Space Weather Technical Forecast

Issued on Saturday, 01 July 2023 at 01:26 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Daily Chance of R1/R2 Radio Blackouts. Chance of G1 Geomagnetic Storm intervals, today.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with X-ray activity at GOES16 showing occasional C-class flares, the largest of which was a C5.7 peaking at 30/1003 from AR3354. This sunspot group is by far the largest and most magnetically complex on the facing side of the Sun, and currently shows as an Fhi/Beta-Gamma-Delta. The group has elongated slightly through the period, with a small overall decrease in penumbral area, but retains two Mt Wilson delta spots. The remaining sunspots, four numbered and two yet to be numbered, are considerably smaller, weaker and magnetically simple.

No Earth directed CME's have been visible in available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as observed by ACE and DSCOVR at L1, indicates a weak connection to coronal hole 18 in the southwest quadrant, as the phi angle was initially negative (towards the Sun), but transitioned to positive from 30/0130UTC.
The solar wind speed was initially at Slightly Elevated levels around 450 km/s but quickly started increasing to Elevated levels, peaking at 592 km/s at 30/1406 UTC, then declining to end the day around 500 km/s. The solar wind density was mostly below average during the morning, then increased to above average levels for the rest of the day, peaking at 14 ppcc early afternoon. The IMF was weak throughout, 7 nT or below, while the Bz was weak, and mainly negative until early afternoon and positive thereafter. The geomagnetic activity was Quiet to Unsettled (Kp 0-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV), as observed by GOES16, was at Background levels.

High energy electron flux (greater than 2MeV), started at Moderate levels but then breached the High threshold (1000 pfu) from 30/1205 UTC, peaking at 2632pfu at 30/1515UTC. The 24-hour integrated fluence was steady at first, but later showed an increasing trend. A fluence of 9.41e7 was recorded at 01/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of reaching Moderate levels of activity with isolated M-class flares, and with a Slight Chance of X-class flares. This risk is almost entirely from AR3354 at first, but may be enhanced by returning regions through the forecast period.

Solar Wind / Geomagnetic Activity: A CME which left the northeast quadrant of the Sun on 27 June may glance the Earth early today, but this is low confidence. A CME associated with the M3.8 flare on the 29th may affect Earth as a glancing blow on Tuesday 04 July.

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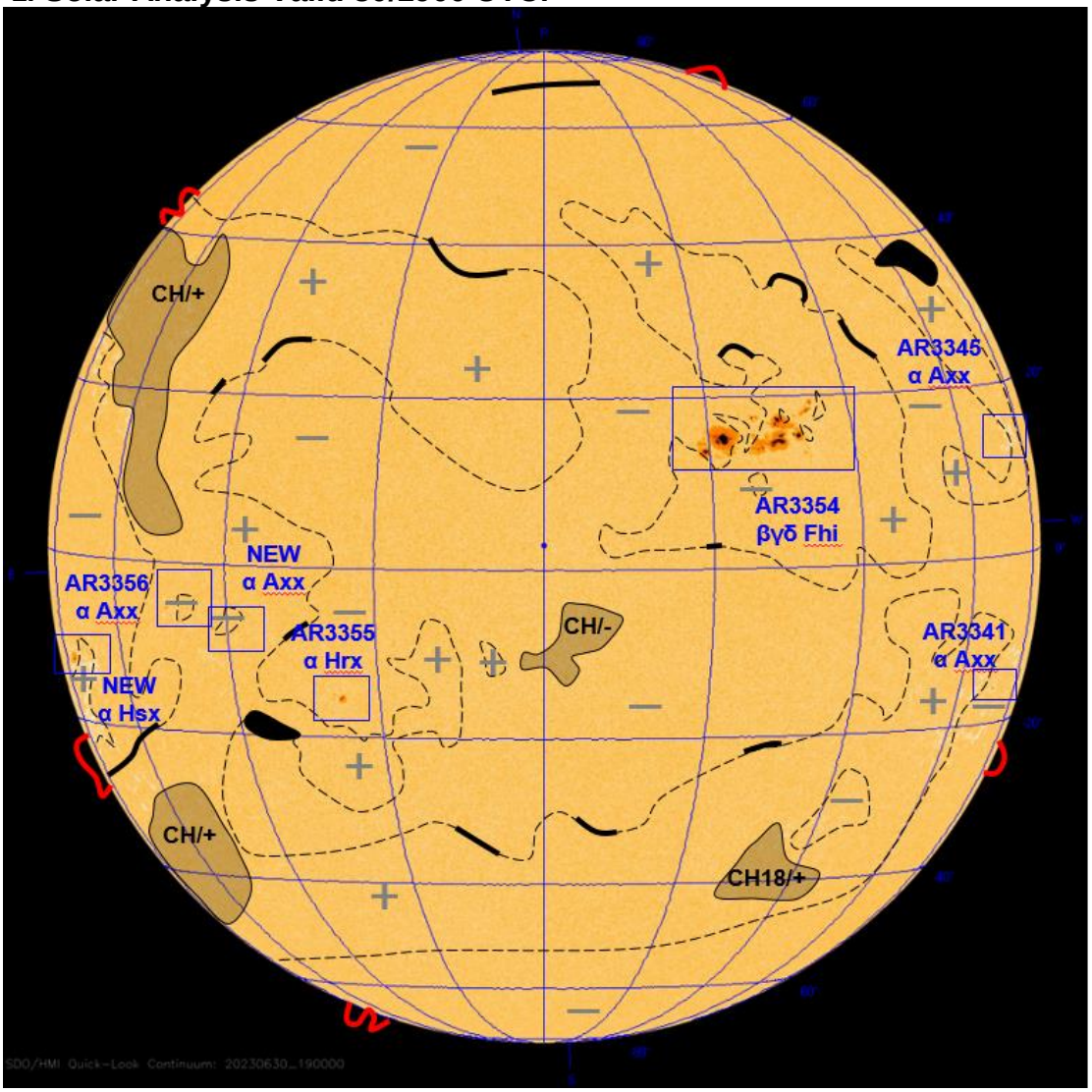
If either or both of the CME's arrive at Earth then Unsettled to Active (Kp 3-4) is likely, with a slight chance of isolated Minor Storms/G1 (Kp 5) activity occurring.
In the absence of CME activity, the current fast wind from CH18/+ is likely to be the only one in the forecast. However, despite the initially enhanced solar wind speed predominantly Quiet (Kp 0-2) geomagnetic activity is expected, before the HSS gradually declines later.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is most likely to remain at Background levels, but with a daily Slight Chance of reaching the S1/Minor Storm level, mainly due to AR3354.

High energy electron flux (greater than 2MeV) is expected to remain at mostly High levels (above 1000 pfu) today and tomorrow, unless the CME from the 27th arrives and geomagnetic activity increases, reducing the electron count. The corresponding fluence is expected to increase to breach the Active (1e8 integrated flux) threshold today. From day 3 (3rd July) the electron flux is expected to be at Moderate to High levels, with the diurnal peaks gradually reducing. Therefore the chance of the fluence exceeding the Active threshold also decreases.

Figure 1. Solar Analysis Valid 30/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the northeast quadrant of the Sun on 27 June may glance the Earth early today July, but this is low confidence, with a potential arrival possible for tomorrow (2nd July). However, if the CME does arrive tomorrow this will indicate a very slow speed, and therefore the CME is likely to have less of a geomagnetic impact. Correspondingly the main chance of isolated Minor Storm/G1 intervals occurring is today, with Unsettled to Active (Kp 3-4) geomagnetic conditions should the CME arrive.

Another CME, associated with the M3.8 flare from AR3354 on the 29th, may have an Earth-directed component. However, confidence for this CME is even lower compared to the one from the 27th, with the CME potentially arriving on day 4 (4th July) and producing Unsettled to Active (Kp 3-4) geomagnetic conditions.

It is therefore very possible, given the uncertainty of the CME arrivals, that the current fast wind from CH18 continues undisturbed until it naturally declines. If this is the case then predominantly Quiet (Kp 0-2) geomagnetic activity is expected.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	30	5	1	20
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
28/0336	Partial	Filament Eruption	NE quadrant, near AR3354 at that time	600km/s	01/0600UTC	Glancing impact possible, but low confidence
29/1415	Partial	Flare	N Centre-disc	762km/s	04/0600UTC	Extreme glance, hence late arrival despite speed.

Figure 2: Enlil ensemble showing the potential CME arrivals.

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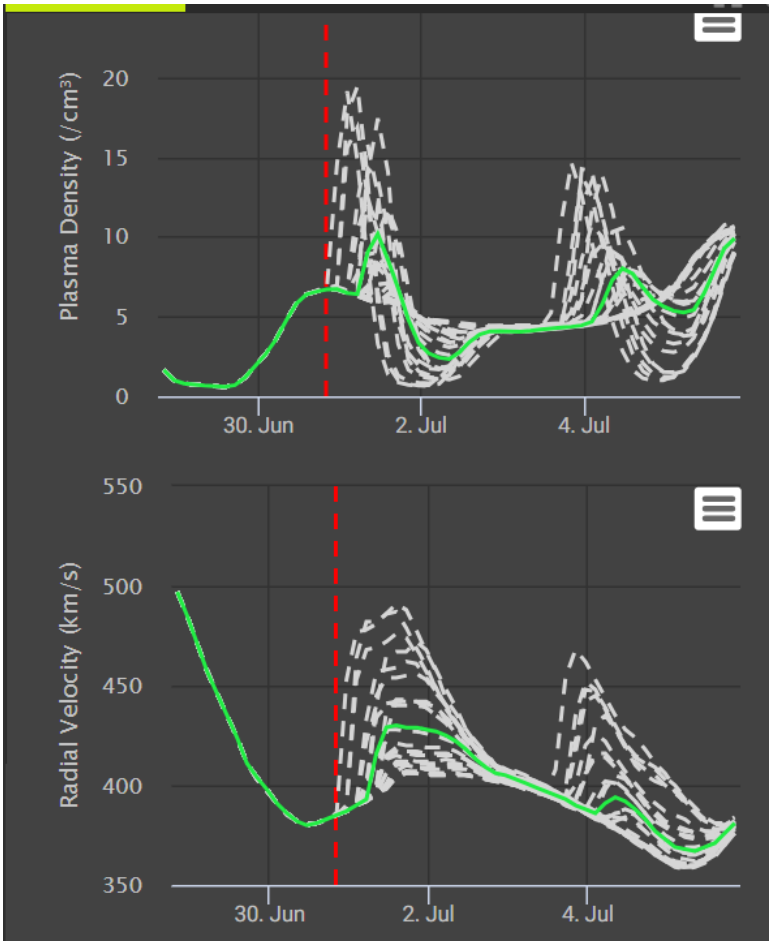

Radio Blackouts - X-Ray Flares:

Solar activity has been Low, with the highest flare of the period a C5.7 at 30/1003 from AR3354. There are now up to seven sunspot regions on the visible disc, five of which are numbered. Of these AR3354 remains by far the largest and most complex region, with two small Mt Wilson delta spots. A3354 has gradually elongated over the past 24 hours, as well as displaying a slight reduction in penumbral area. All other spots are small, simple and stable. There is a daily Chance of reaching Moderate levels of activity with isolated M-class flares, and with a Slight Chance of X-class flares. This risk is almost entirely from AR3354 at first, but may be enhanced by returning regions through the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

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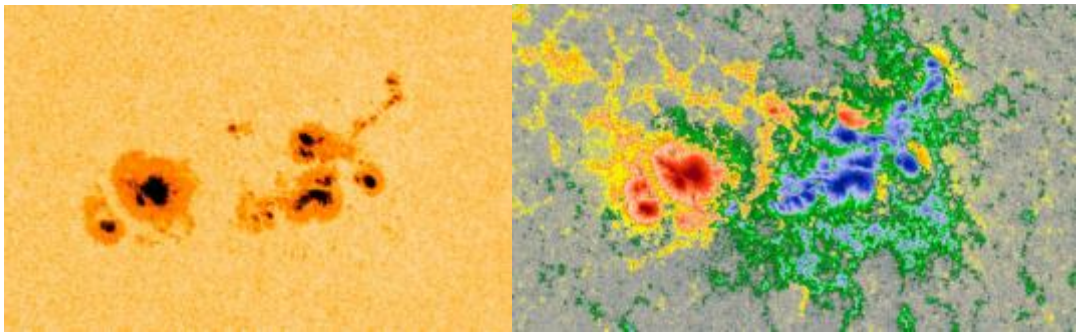
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	40	40	40	40
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: AR3354 as seen in SDO AIA imagery (left flattened intensitygram and right magnetometer).



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux, as observed by GOES16, is at background levels and is most likely to remain so throughout the period.
However, there is a Slight Chance of S1 levels being reached due to the potential for AR3354 to produce significant flares, and with AR3354 being located within the western hemisphere.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The current enhanced solar wind is from the only coronal hole HSS to contribute to the forecast over the next four days, from CH18. A continuation of flux and fluence levels near those seen at

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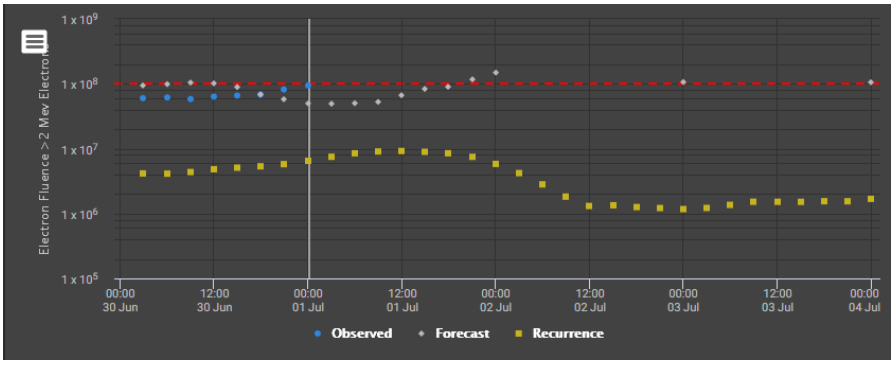
present is the most likely scenario during the forecast period, although with an increase intitially before a gradual reduction likely later in the period. Therefore, the Met Office REFM model is appears to be offering good guidance, although the increase of the fluence above the Active threshold (1e8 integrated flux) is considered to be too slow.
However, the potential arrival of two CME's, either today or day 4 (4th), may increase geomagnetic activity and lower the electron cloud at a much quicker rate.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	90	80	60	40
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Met Office REFM model.



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